



CHP for Buildings IES Peer Review

May 2, 2002



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Goals per DOE Request for Proposal

- Integrated **E**nergy **S**ystem for Commercial Buildings
- Focus on Pre-Engineered Package - Optimized to:
 - ✓ Improve Efficiency
 - ✓ Increase Reliability
 - ✓ Reduce First Cost
 - ✓ Reduce Maintenance Costs
- Phase 1 R&D Statement of Work:
 1. Plan
 2. Concept (including market analysis)
 3. Optimization
 4. Test Standards
 5. Prototype
 6. Lab Testing
- Phase 2 Commercial Demonstration





Project Team

Initial Team Members:

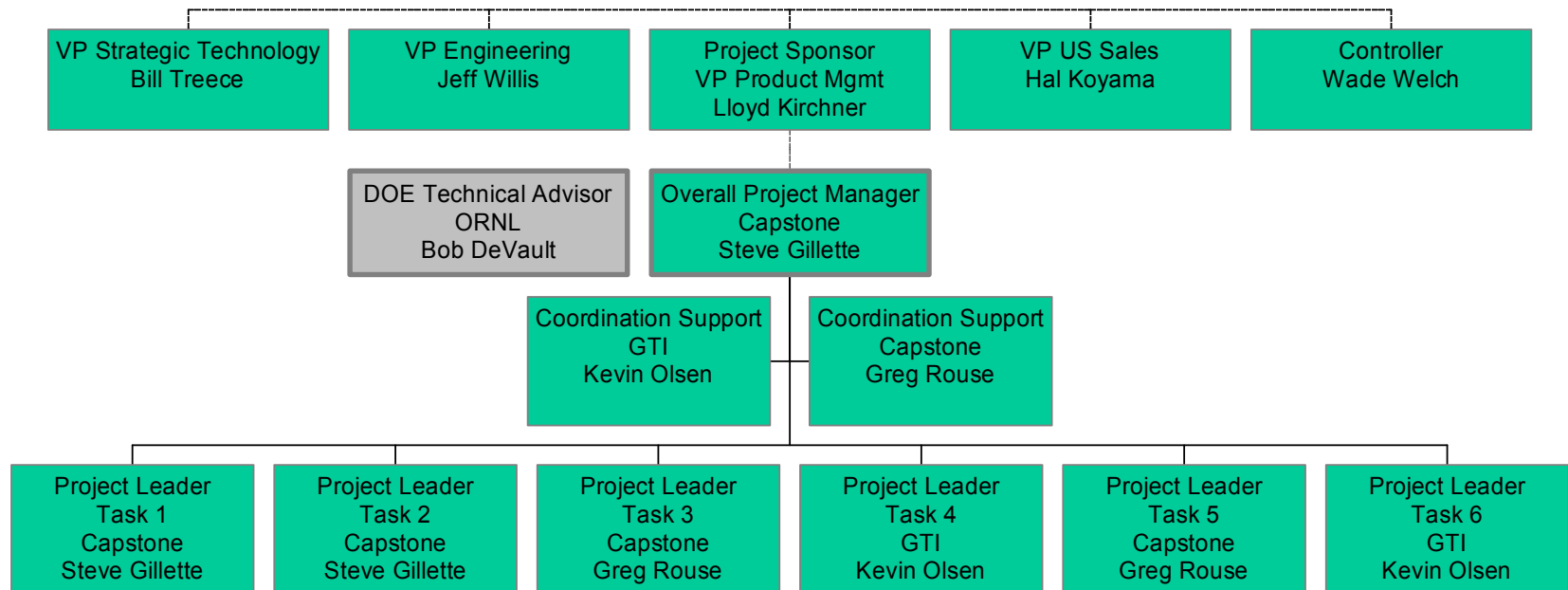
- Gas Technology Institute
- University of Illinois at Chicago
- Takuma Co., Ltd.
- Broad USA, Inc.
- Capstone Turbine Corp.

Additional Team Members TBD

- Focus on Optimum System



Project Organization



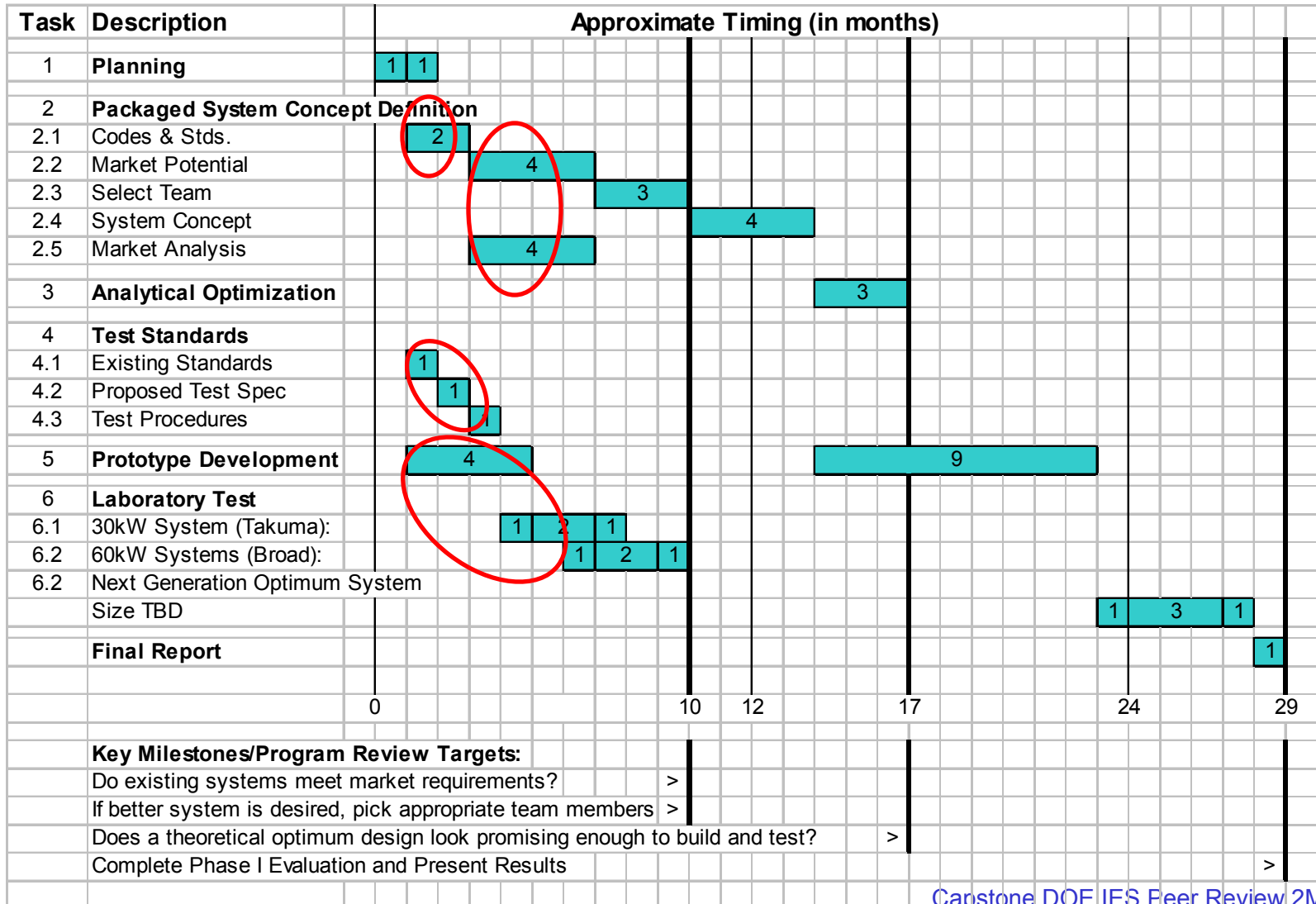


Development Plan Summary

- Test Near-Commercial Absorption Products Early
 - ✓ Utilize Direct Exhaust Firing
 - ✓ 30kW Capstone with Takuma 12-14RT
 - ✓ 60kW Capstone with Broad 23-25RT
- Complete Market Analysis in Parallel
- Define Concept & Partner for Optimum Prototype
- Expand Team as Needed
- Benefits:
 - ✓ Potential Early Commercial Product Availability
 - ✓ Strong Basis for Optimum Concept Development



Overview of Major Tasks





Packaged Concept Definition (Task 2)

Codes & Standards Review (Task 2.1)

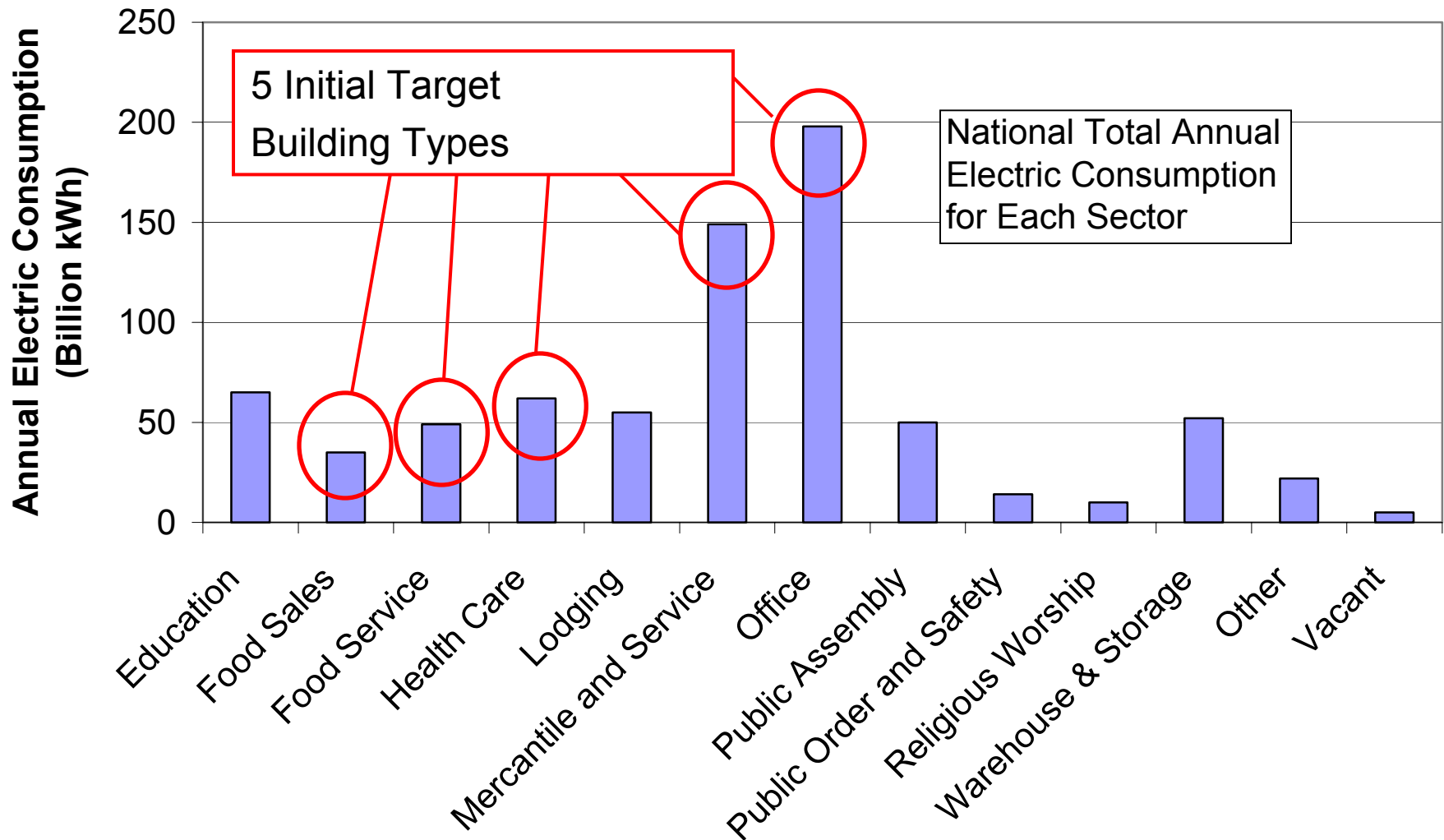
- GTI Compiling Relevant Local Building Codes into Searchable Document
- Expected Completion May

Market Assessment (Tasks 2.2 & 2.5)

- Initial Target Building Types Defined
- Details for 2 of the 5 Initial Target Segments Defined
- Initial Model for IES Package Completed
- Preliminary DOE-2 Simulation for One Building Type



Initial Target Building Types

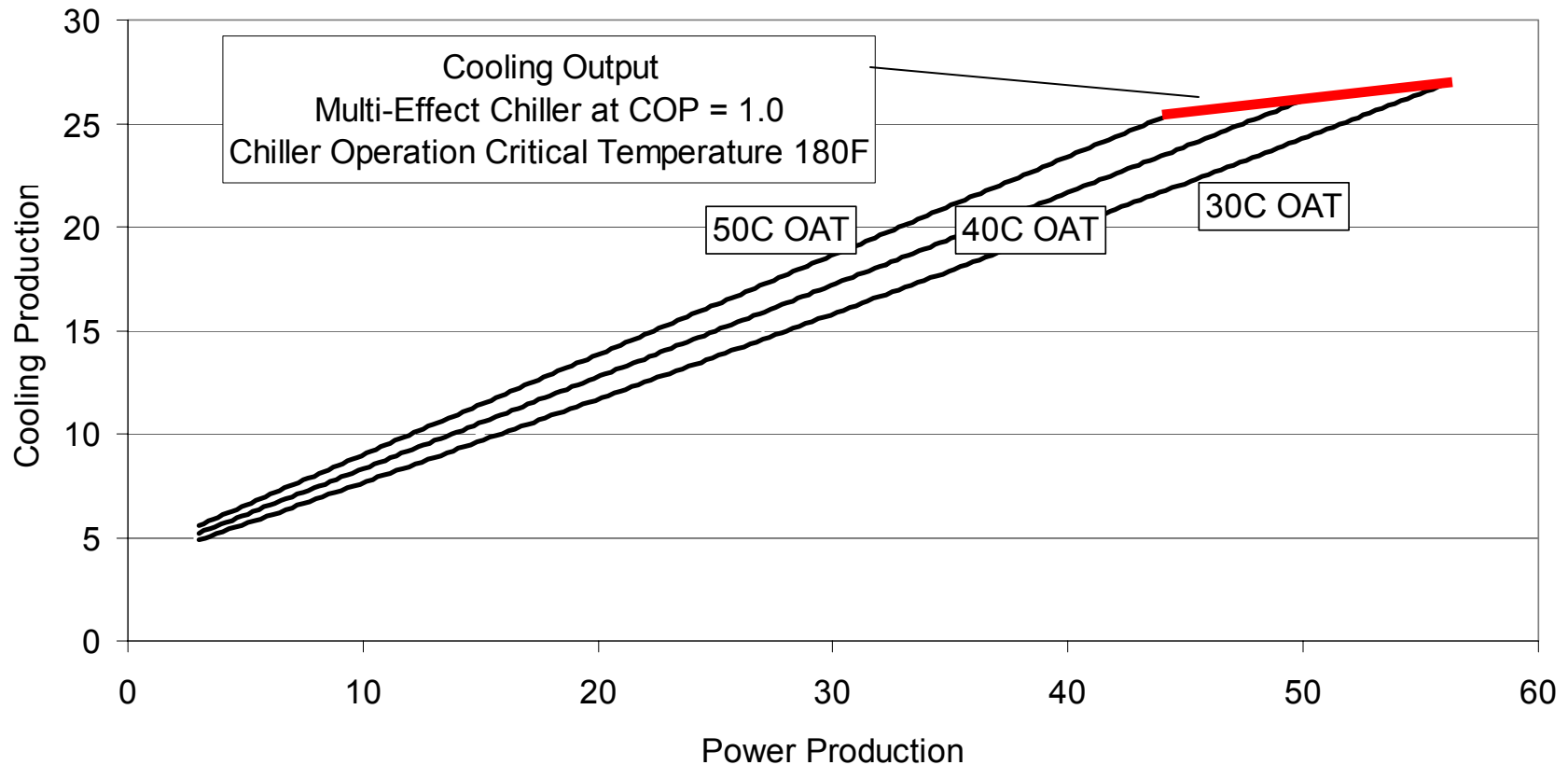


Source: EIA 1995 Survey

Capstone DOE IES Peer Review 2May02



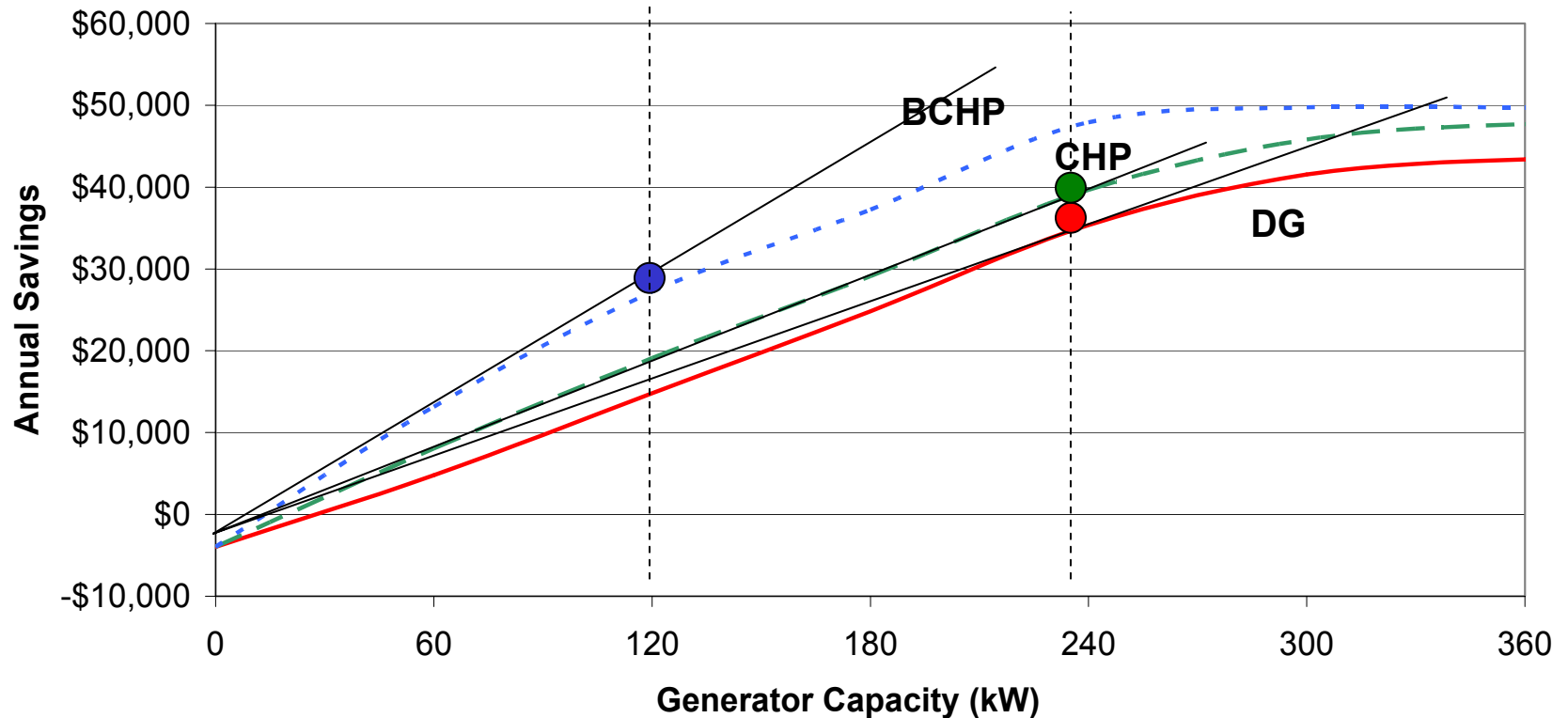
Preliminary IES Performance Model





Example DOE-2 Simulation Result

Estimated Savings



Optimum Economic Situation

Largest System Along Constant Slope Section of Graph
Slope Declines to Maximum Indicating Deteriorating Value
Of Each Added Unit of Capacity



Test Standards (Task 4)

Existing Standards (Task 4.1)

- Relevant Distributed Generation (IES) Equipment Performance Standards Compiled by GTI

Proposed Test Spec (Task 4.2)

- GTI to Complete in Combination with Separate Project
- GTI working in conjunction with a nationally recognized standards organization for standards development.

Test Procedures (Task 4.3)

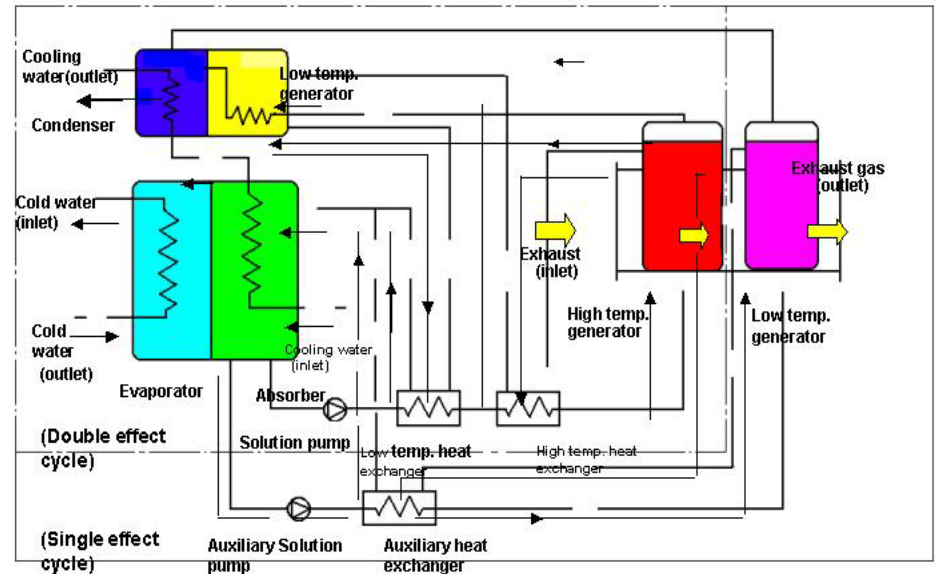
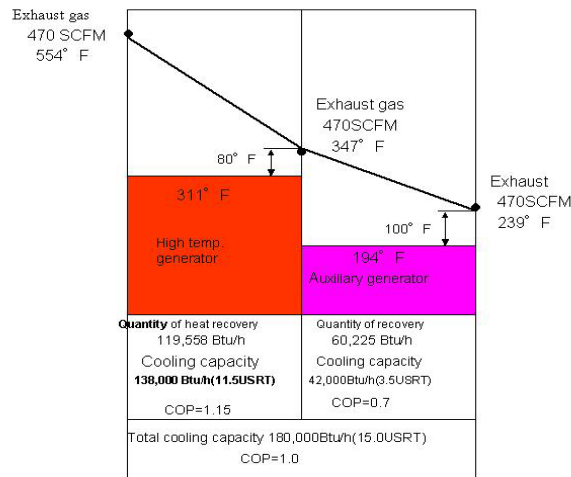
- Procedures for Initial Prototype Testing Completed
- Revisions to be made based on Task 4.2 and experience testing first two prototypes



Prototype Development (Task 5)

Takuma/Capstone Prototype (Task 5.1)

- Expected Performance:
30kW Electrical
12-14 RT Chilling
- Prototype Delivered
- Commissioned at GTI
- Testing Underway





Prototype Development (Task 5)

Broad/Capstone Prototype (Task 5.2)

- Expected Performance:
60kW Electrical
23-25 RT Chilling
- Prototype Design Completed
- Expected Shipment June
- Similar to System at Univ. of Maryland
(due to start operation May, 2002)



Laboratory Testing (Task 6)

Takuma/Capstone Prototype (Task 6.1)

- Testing Underway



Purpose of Testing

- Performance
 - ✓ Unit Efficiency
 - Turbine
 - Chiller
 - ✓ Overall System Efficiency
 - ✓ Emissions (NO_x, SO₂, CO, CO₂)
- Verification/Collection of Application Data
 - ✓ Gas Consumption
 - ✓ Heat Rejection Rates
 - ✓ Part Load Performance
- Recommendations for Improvements
 - ✓ Identify Lessons Learned in Installation
 - ✓ Package Improvements
 - ✓ System/Control Scheme Improvements
 - ✓ Recommendations for Building Sector Application Designs (Conceptual)



Project Challenges

End-User Value

- Focus on Direct Exhaust Fired Thermally Activated Technologies
- Confirm Economics of Current Prototypes
- Investigate Technology Options
 - ✓ Performance/Cost Tradeoffs
 - ✓ Maintenance & Reliability (e.g. Air Cooling)
 - ✓ Addition of Desiccant Technologies

Integration with Existing HVAC systems

- Mix with Traditional Technologies
- Building Control & Communications to Optimize Savings



Remaining Tasks for FY2002

Complete Market Analysis and Confirm Viability

- Modeling of 5 Building Types in Different Geographies
- Interviews with Prospective Target Customer Types

Complete Laboratory Testing

- Takuma/Capstone
- Broad/Capstone

Propose Integrated Energy System Test Standard

Select Team for Optimum Design Concept

- Define Contributions from Each Team Member
- Schedule & Budget for FY2003
- Define Specific Technology Challenges



Project Summary

Prototype Performance Encouraging

- DOE Efficiency Targets of 70% Seem Achievable
- Clean Emissions and Simple Interconnections

Significant Total Market Opportunity

- Looks Attractive for the Target Building Types Selected

Potential for Early Commercial Installations

- Prototypes can Confirm Reliability and Total End-User Value

Optimum Design Could Improve Economics

- Technical Risk and Opportunity will be Clear this FY